JOINT STRIKE FIGHTER
the next generation strike fighter

JSF Modeling Information Management

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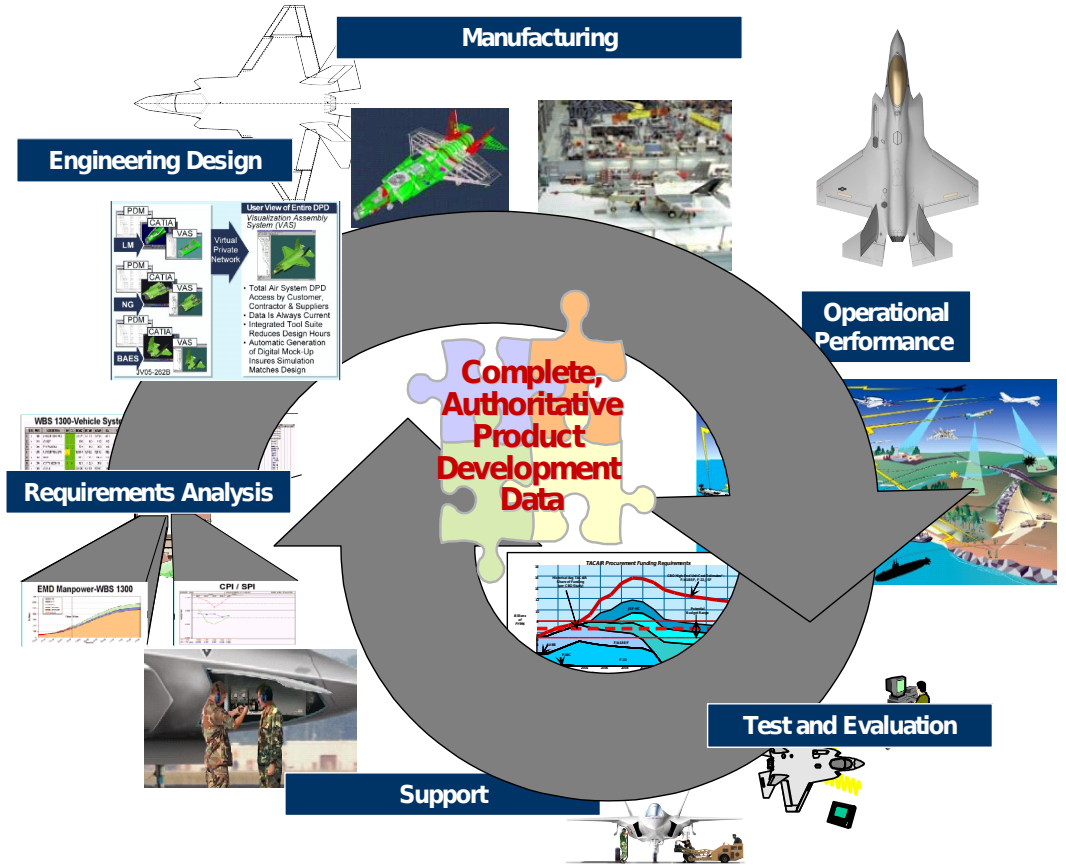
Simulation Based Acquisition (SBA): Shared Information is the Hub of IPPD

JSF Program Commitment:

- ***Availability of complete consistent digital product data***
- ***24/7 access and navigation of digital product data by the entire team***
- ***Data interoperability between team and suppliers***
- ***Configuration management and publishing in-progress designs***
- ***Accreditation and traceability of digital product data***



Consistent, Authoritative and Readily-Available Information is Vital

- **To produce the JSF**
  - Coordinate development activities, assess development progress
  - Reduce the confusion and risks that arise if operating on wrong or logically inconsistent information
  - Establish validity of M&S-based analyses by tracing results back to authoritative information
- **To conserve resources**
  - Avoid having to repeatedly find, produce and/or translate the same information
  - Enable more timely analyses, resulting in shorter decision cycle times and more efficient systems engineering
  - Avoid the costs of mistakes that arise from bad information

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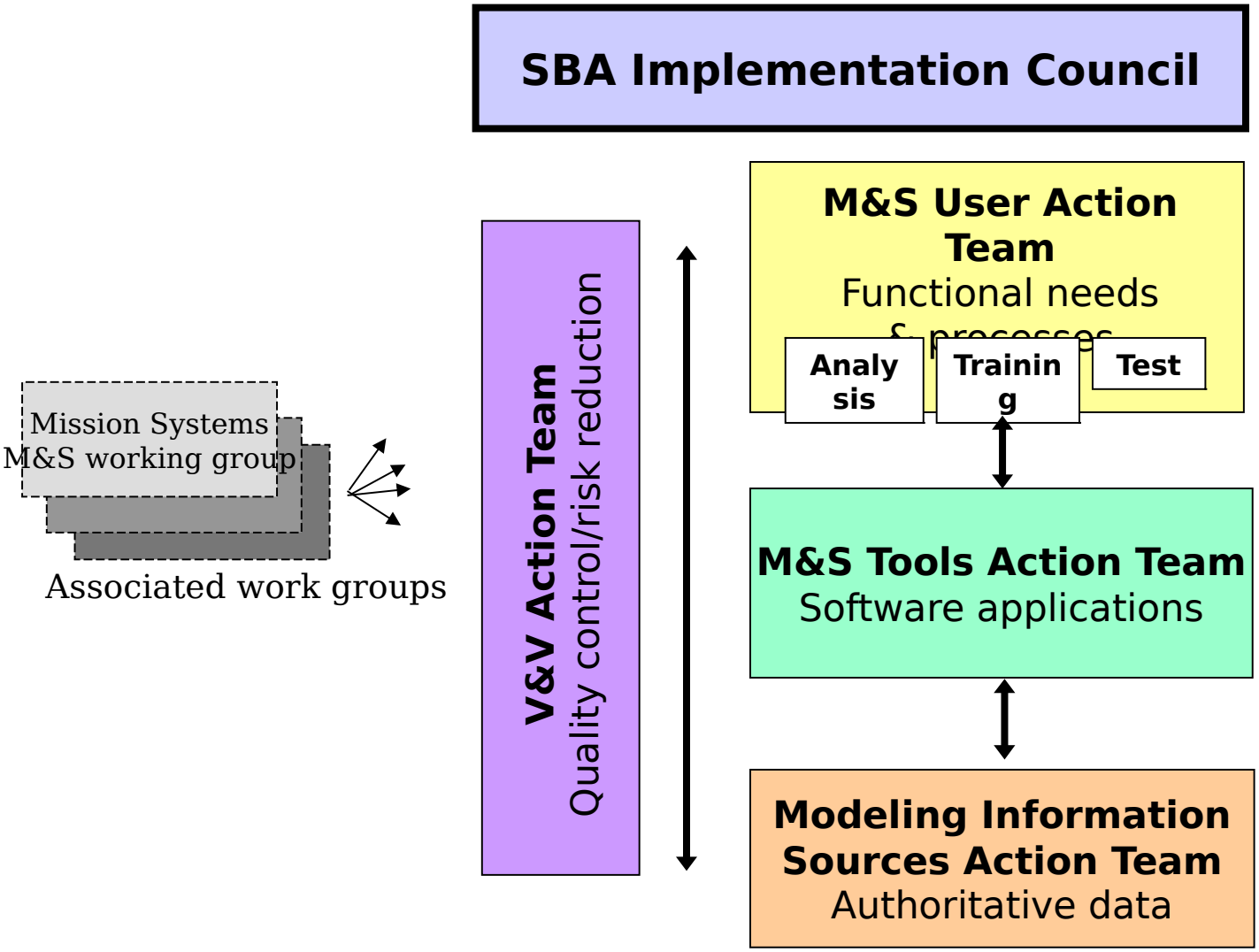
JSF Simulation Based Acquisition Implementation Team



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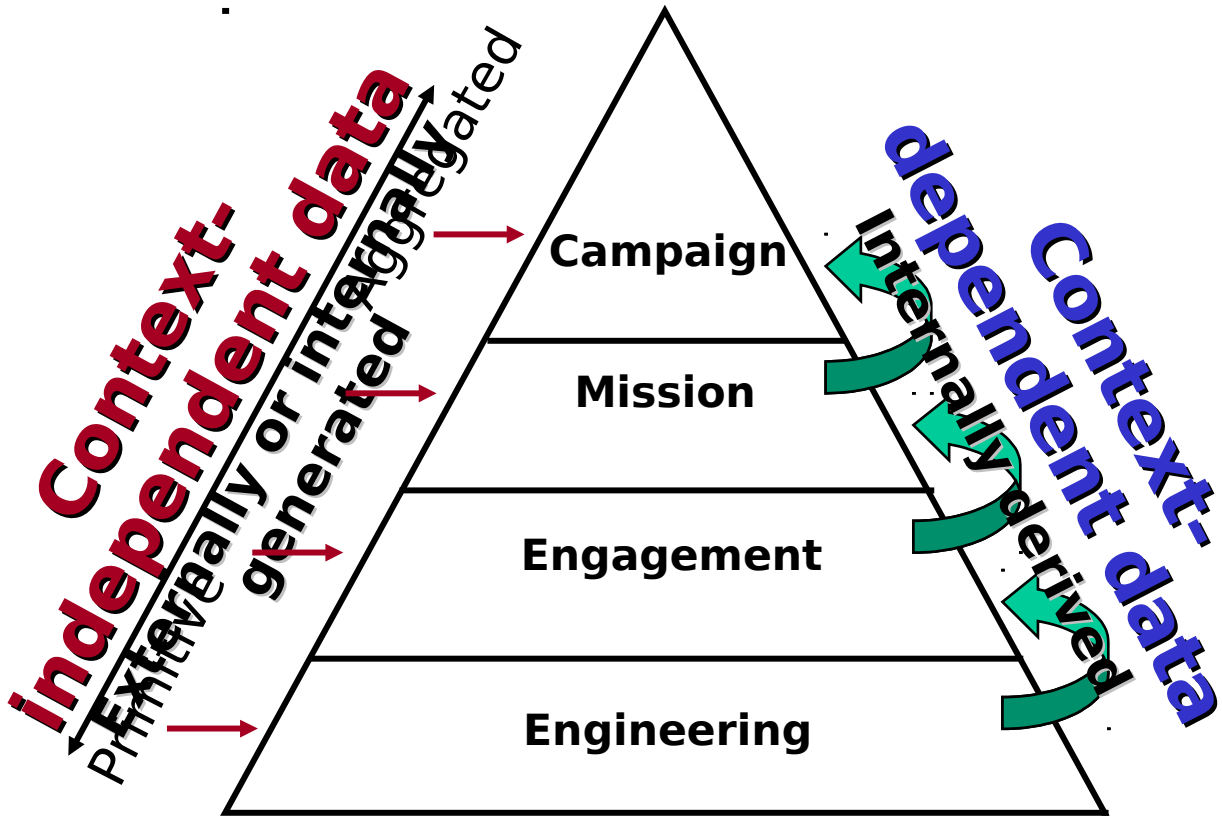
Data Inputs



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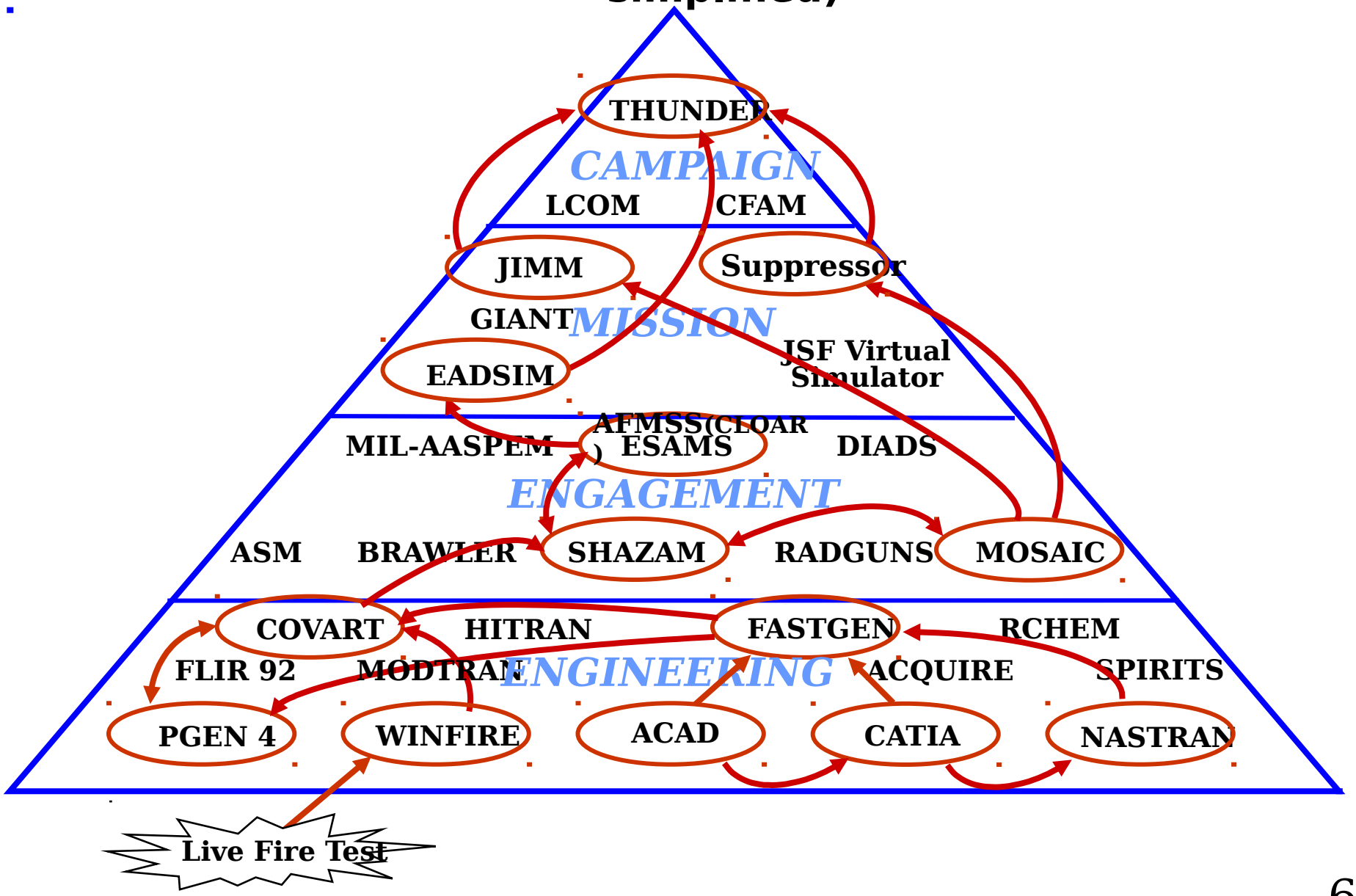
Data Lineage Example

(Surface-to Air Missile Vulnerability Analysis - simplified)



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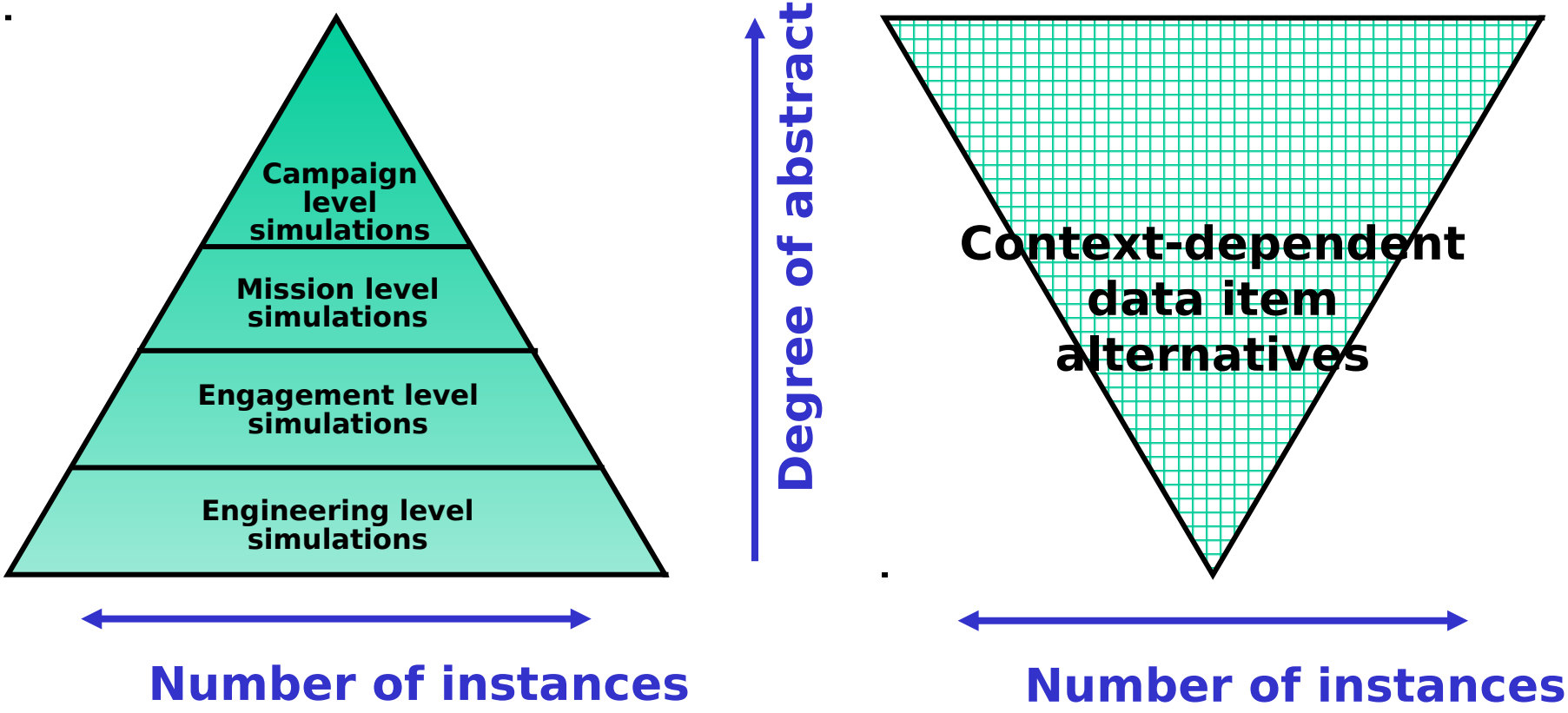
Inverse Abstraction Relationship



- Data applicability narrows as context dependencie
- Standard contexts reduce instances that must be
- Include context in metadata to guard against inap

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JSF Authoritative Modeling Information System (JAMIS) Information Flow Concept

Design change orders

Authoring tools (e.g., architecture, CAD)

Register proposed designs (LM Aero)

Resource Access System (RAS)

Register design decision

JSF design chang decisions

JSF [DPD]

Interactions (P_d, P_k,etc.)

Threat & friendly systems [ASDB]

Natural environment infrastructure

Operational context

Study-specific archives

User interface admin data

Digital System Models

linking & translation services (mapping, semantics, syntax)

JSF control boards

Program Offices

Blue system C&P info

Intel Centers

Threat C&P information

NIMA, DTRA, NRO, etc.

Natural environment & infrastructure C&P info

Register authoritative data (JSFPO)

Services JFCOM, etc.

Operational context info

LM Aero Team Operational Test Authorities

Register DT & OT test results

Register smoothed / analyzed results

Design change MoMs

SMs / relevant info tool-specific for

Analyst action

Raw M&S results

Study-specific input datasets & software code

Analysis tools (e.g., models, simulations)

Color key:

JSFPO provided

LM Aero provid

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JAMIS Operation Roles and Responsibilities

JSF SORA & LM Aero Tier III IPT directors: Grant privileges

Manager : LM Aero, in cooperation with JAMIS database managers

- Implement privileges
- Provide training and technical support

Technology development

External references (e.g., Intel Centers)

Producers : Designers, JSFPO, analysts, testers

- Review data & metadata
- Register data
- Author metadata

JSF Authoritative Modeling Information System

Consumers : JSF Enter- prise, others TBD

- View data & metadata
- Download & use data

Analyses and testing

Examiners : VV&A Action Team, others

- View data & metadata
- Assess & mark (in metadata)

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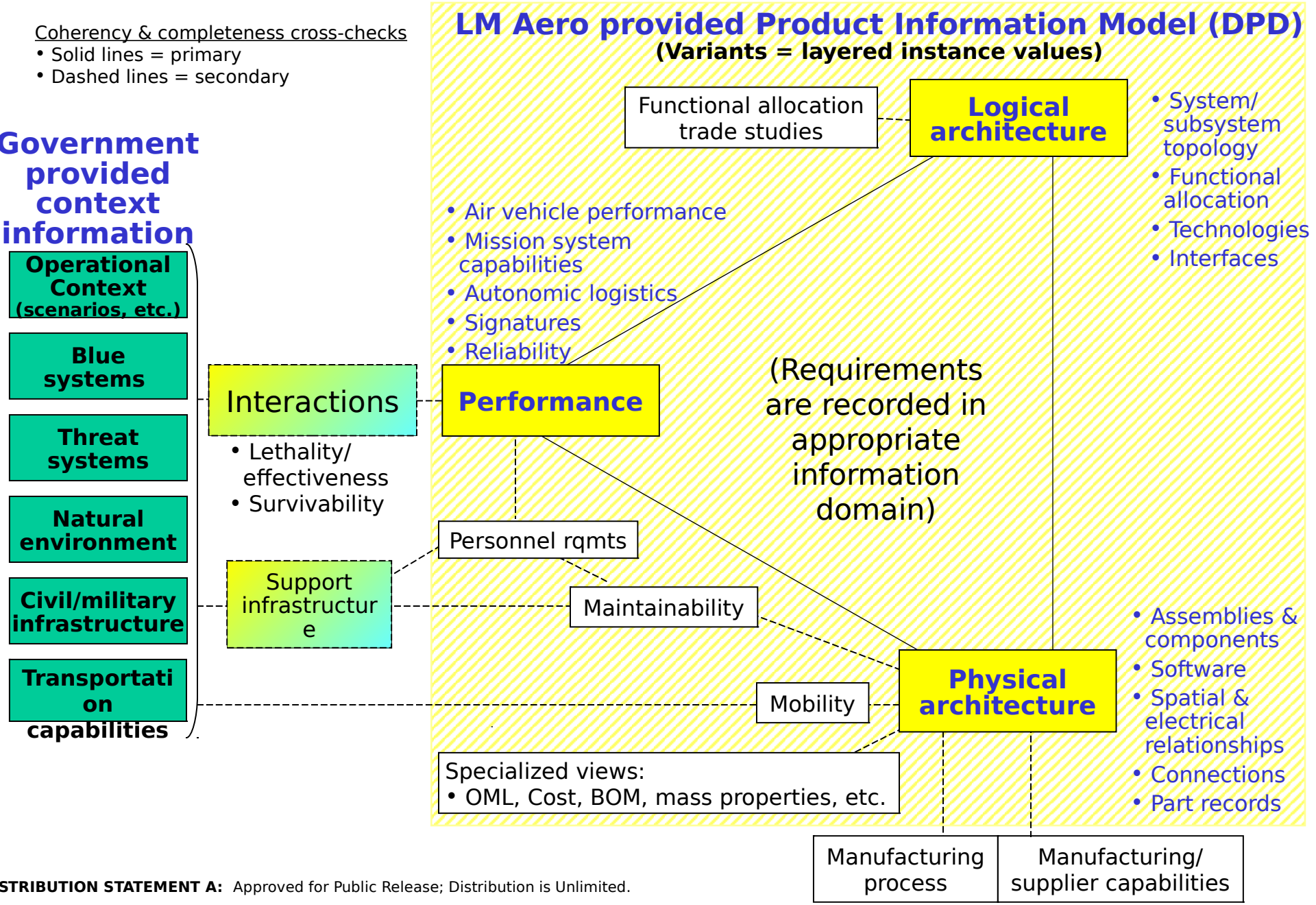
JSF Product Development Information Model Scope



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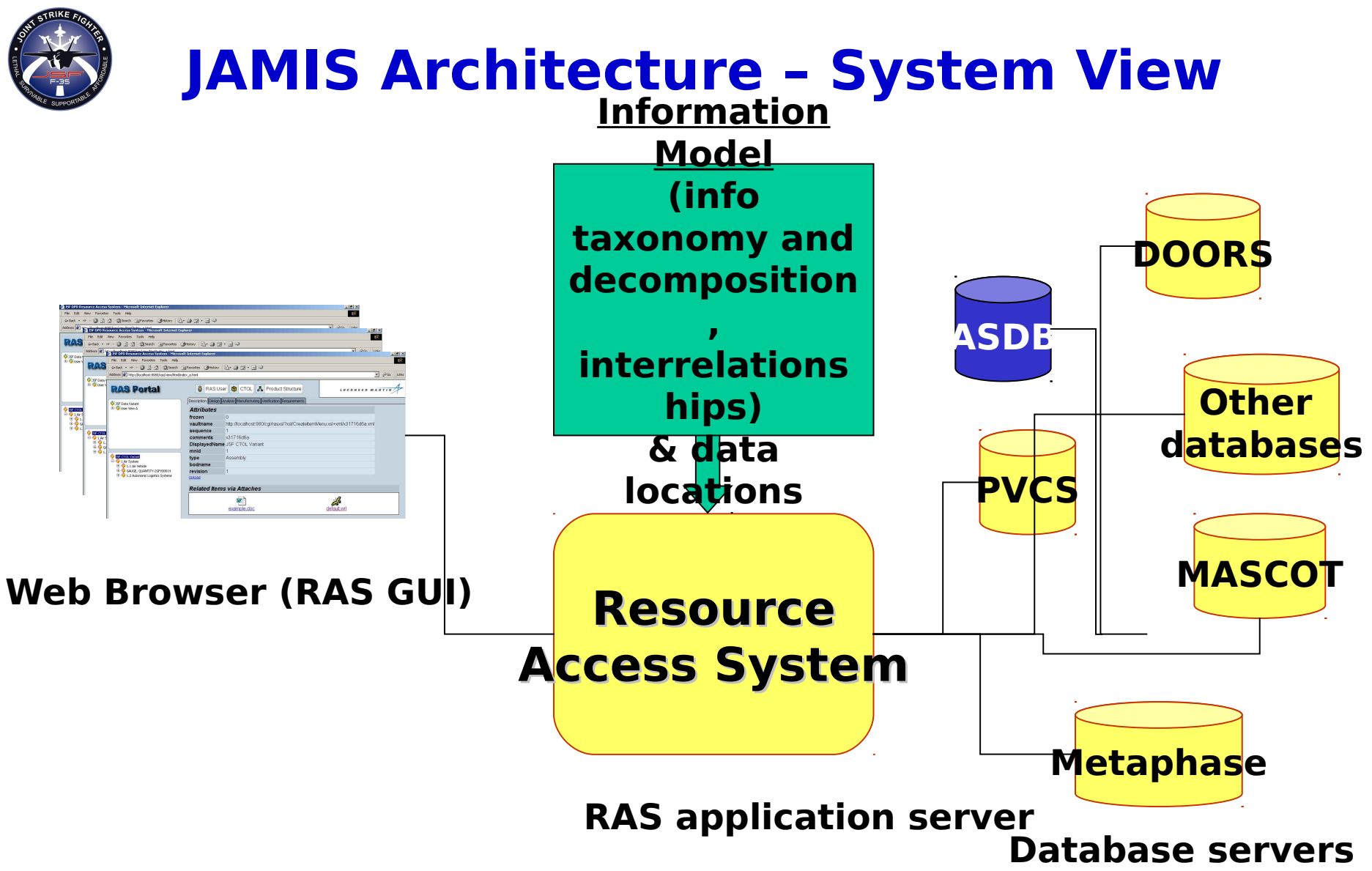
JAMIS Architecture – System View



Information model as means to locate, navigate, and access distributed data

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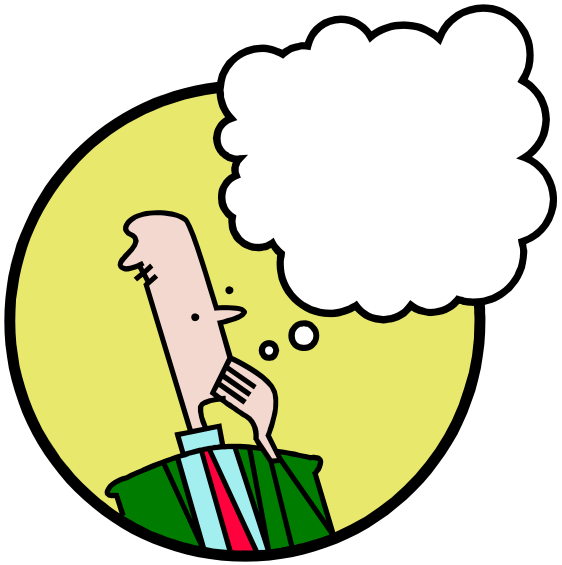
Challenge: Information Mapping



Professional disciplines, and M&S developers, represent (model) things in widely differing ways

- Conceptual views (abstract ways of thinking about what's involved)
  - What entities, attributes, actions and interactions are represented, at what level of granularity, etc.
- Contexts in which information is valid
- Semantics and syntax of individual data items

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Dimensions of Information Coherency

Temporal coherence

- The extent to which the data being used for different tools and sites has the same time stamp

Organizational coherence

- The extent to which all enterprise organizations are using the same set of databases

Layer (tier, level, stratum) coherence

- The extent to which all the information at a given level of granularity (e.g., engagement level) is logically consistent

Perspective coherence

- The extent to which information from different perspectives (e.g., logical, physical, behavioral) is logically consistent

Abstraction coherence

- The extent to which the information at different levels of granularity is logically consistent (the context dependency issue)

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Development Strategy

- **Due to the absence of MLS and two-way guards, we are establishing separate JAMIS instances at each security classification level**
  - Unclassified, SECRET Collateral, TOP SECRET SAR
- **Spiral development**
  - A series of builds, prioritized per program needs, to support:
    - An increasing amount of information
    - An increasing numbers of tools
    - Interfaced to an increasing number of organizations
  - Version 3 in development now

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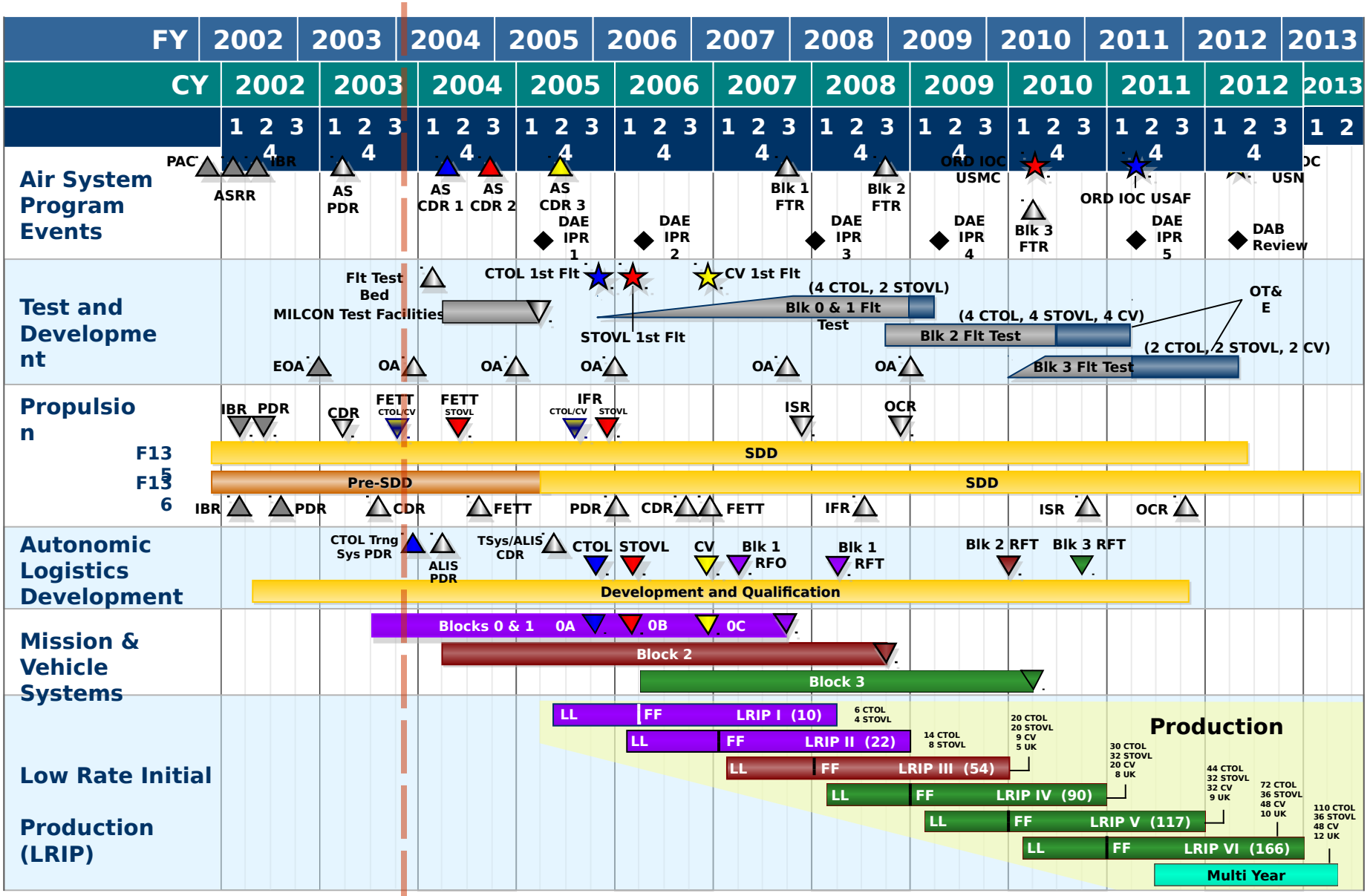
JPO TOP LEVEL SCHEDULE



Version 8a – current as of 28 Feb 03

A Few Challenges

- **Fostering broad understanding of the need and the solution concept**
- **Integrating into the system engineering process**
- **Finding authoritative data sources**
- **Overcoming reluctance to release data**
- **Replicating less classified data at higher levels**
- **Providing lower level representations of highly-classified data**
- **Accomplishing the data engineering**

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Discussion

Summary

- **Breaking new ground in management of modeling information**
- **Information technology advances don't solve all challenges**
- **Holistic approach and good systems engineering are required**
- **Promises to advance state of the practice, impact SBA concepts**
- **Still a work in progress**
  - Incremental deliveries, incremental changes for users
  - Wish had started sooner!
- **Many challenges common to other acquisition programs**
  - DoD/Service-level actions could help

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Information Types

- Parametric data
- Algorithms
- Software code
- Publications
- Subject Matter Expert knowledge

Initial focus has been on parametric data

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Modeling Information Characterization

- **Regardless of its subject, data may be characterized by its:**
  - Trustworthiness: "authoritative" or "non-authoritative"
  - Evidence in the real world: "empirical" or "derived"
  - Context dependency: "context-independent" or "context-dependent"
  - Granularity: "primitive" or "aggregated"
  - Structure: "atomic" or "complex"
  - Source (relative to the enterprise): "external" or "internal"
- **Above characterizations are orthogonal**
  - A data item could be described by any combination

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Operational Context DB Scope

(Enterprise-wide standards for analysis; in priority order)

1. **Scenarios**
   - Road to war
   - Blue TPFD
   - Orders of battle (UOB, EOB, etc.)
   - Geographic area
   - Infrastructure targets, location
2. **Mission Groups**
3. **Missions**
4. **Vignettes** *(created by JSFPO)*
5. **Use Cases** *(created by JSF IPTs)*
   - Initiating inputs, required actions, MOPs
6. **Natural environment conditions**
   - Time of day, weather
7. **Concept of Operations (CONOPS)**
8. **Force doctrine**
9. **Tactics**
10. **Rules of engagement (ROE)**
11. **Firing doctrine**
12. **Infrastructure lay down** (other than targets)

<u>Not</u> in Operational Context DB:

- Study-specific archives
  - Input data sets
  - Raw execution outputs
  - Discretionary analyst decisions
    - e.g., Blue mission routes
- System C&P data
- Natural environment instance data
- Infrastructure C&P

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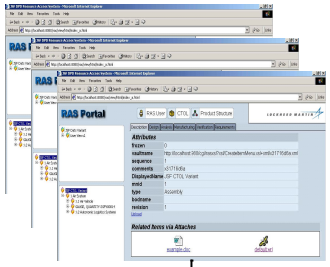
JAMIS Architecture - System View



Internet Explorer (RAS GUI)

Resource Access System

Product Development Info Model + Storage Locations

PDM System

DPD data

Metaphase

DPD data

JDL

DPD data

Other DBs

DPD data

DOORS

DPD data

PVCS

Other develop. data

ASDB

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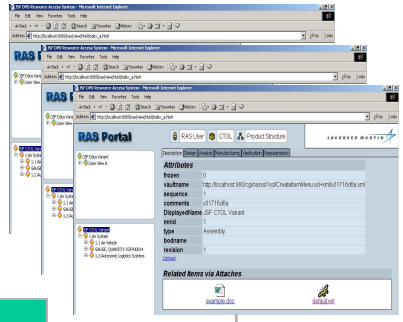
System View



The Resource Access System provides 24/7 Web-access to a single, logically unified JSF representation of variants, and configurations

The PDM System (PDMS) is a federated set of data management systems for development and release control of product data

Resource Access System

Product Development Information Model

The JSF Product Development Information Model provides a catalog structure for the DPD represented in the RAS interface

Product Data currently in JDL will transition to Metaphase

The DPD is the release controlled product data contained in the Product Data Management System

PDMS

DPD data

Metaphase

ASDB

JDL

DPD data

PVCS

DPD data

DOORS

DPD data

Other DBs

DPD data

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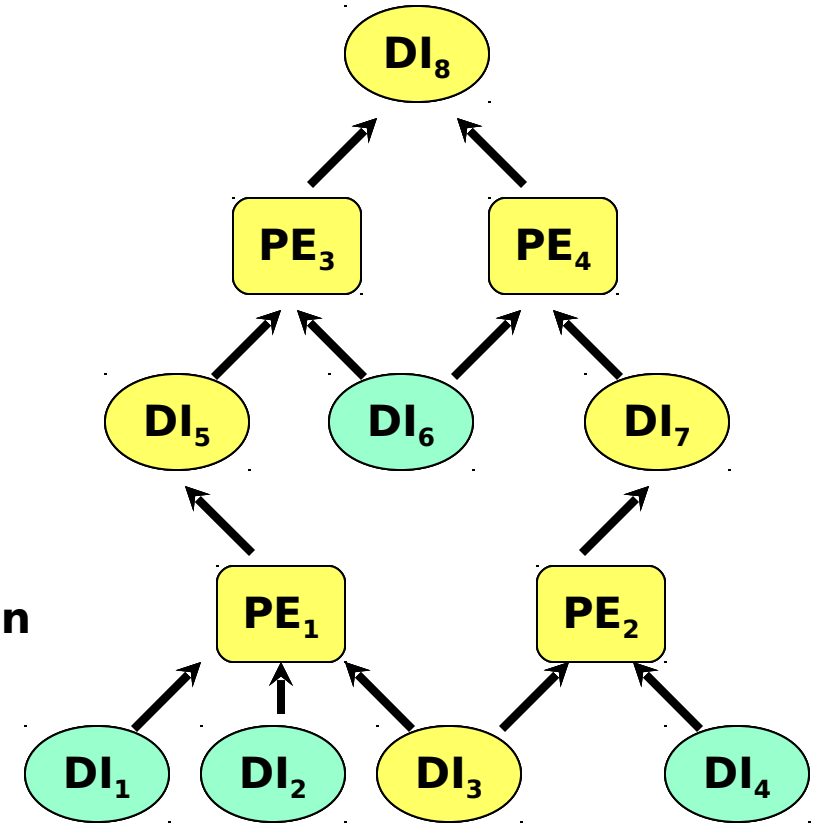
Impact Analysis and Consistency



DI – Data Item
PE – Process Execution

<u>Impact Analysis:</u> A change in D1 potentially necessitates the re-execution of PE1 and PE3 to produce DI5 and DI8.

<u>Consistency</u>: A consistent version of DI3 must be used to eventually produce a coherent version of DI8.

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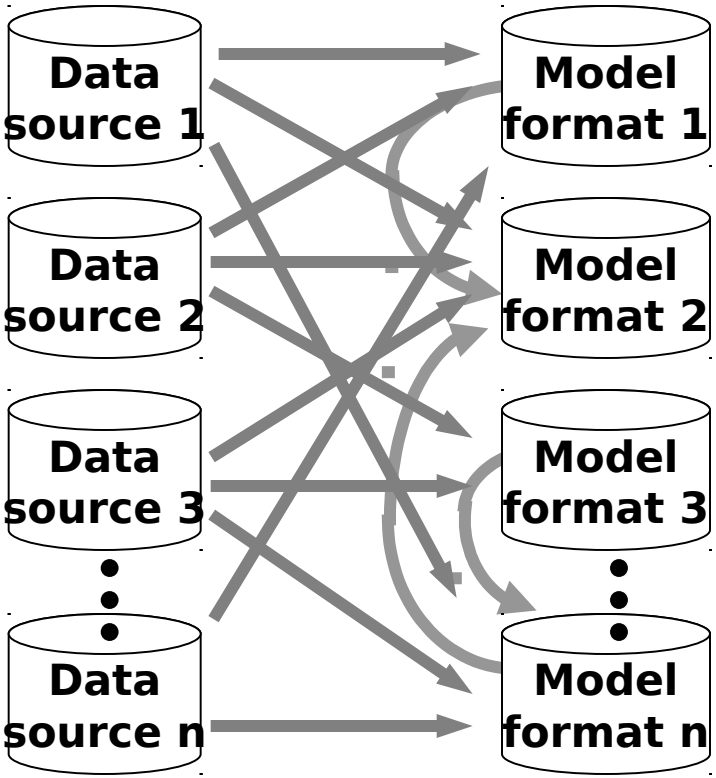
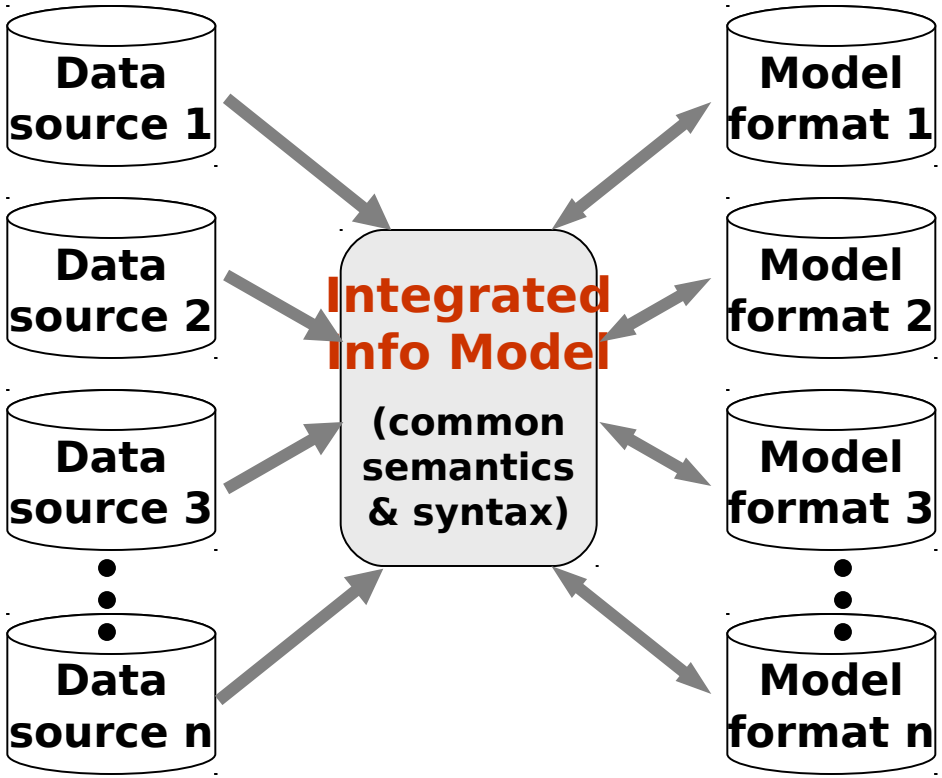
Rationale for a Integrated Information Model



Many translators (~N^2 for N tools)

Difficult configuration management



Fewer, less fragile translators

Easier configuration management

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Practical Limitations

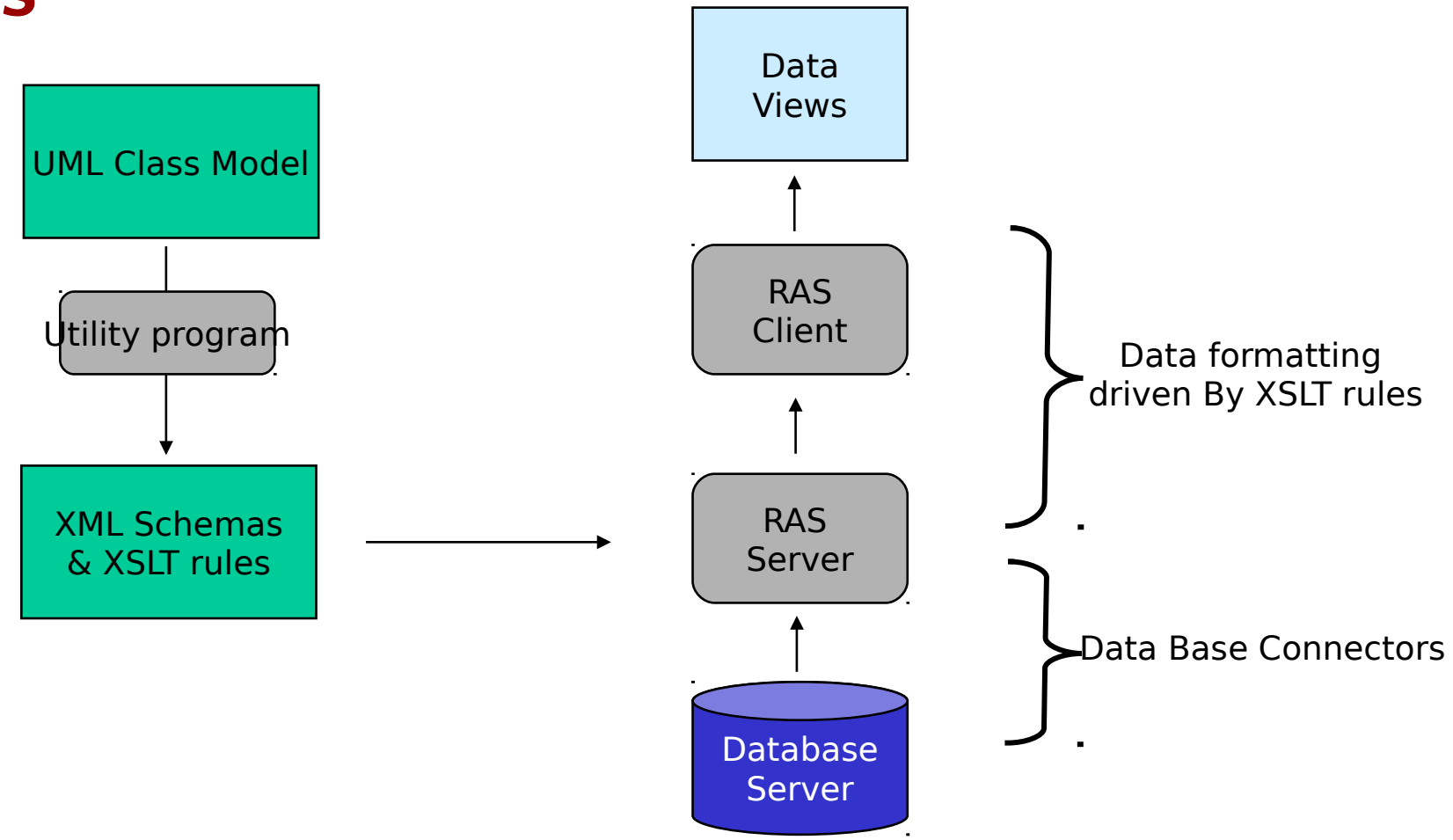
- **REDIS process works in domains with high semantic similarities**
  - Similar ways of looking at the world
- **Synthesizing an integrated information model requires an intimate understanding of the producing and consuming tools (models, simulations)**
  - Usually a time-consuming task
- **Conceptual model & assumptions of the tools are often unclear**
  - Developer may not have documented this
  - May be a function of the analysis to be performed

Automatic translation of source data into input data sets has practical limits

- Much responsibility must be left with the analyst

Information Model is Maintained as a UML Class Model

…which is used to generate XML schemas that are loaded into RAS



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Recommendations: DoD Data Policy

- **Information is a DoD corporate resource**
- **Establish means to capture data needs**
  - similar to Intel Center 'Production Requests'
- **Crisply define production "swim lanes" & responsible organizations**
  - Government data rights for all reusable data (contracting policy)
  - Business/funding rules
  - Report cards
- **Define user responsibilities and liabilities**
- **Establish means to appeal data release denials**
- **Provide visibility/awareness means**
  - Internet and SIPRNet registries of core metadata about the data assets, not the data itself
    - Database description, format, security classification, date, POC, etc.

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Recommendations: Standards

- **Need tool standards, not standard tools!**
  - Tool standardization is impractical, costly, negates power of marketplace
- **Define standard data interchange formats (DIFs)**
  - Need more, better DIF standards (at the 'payload' level)
    - Well-defined semantics & syntax
    - Standard metadata, including context dependencies
    - More granular, less overlapping
  - Need DoD to use its 'bully pulpit', be engaged
  - Define DoD-sanctioned venues for standards development
    - Commercial standards landscape is quite confused, both nationally and internationally
    - NIST can help
- **Define full range of standard operational contexts**
  - Reduce context-dependent data alternatives to a manageable level
  - Start with Design Reference Missions for each mission area, flesh out down to tactics

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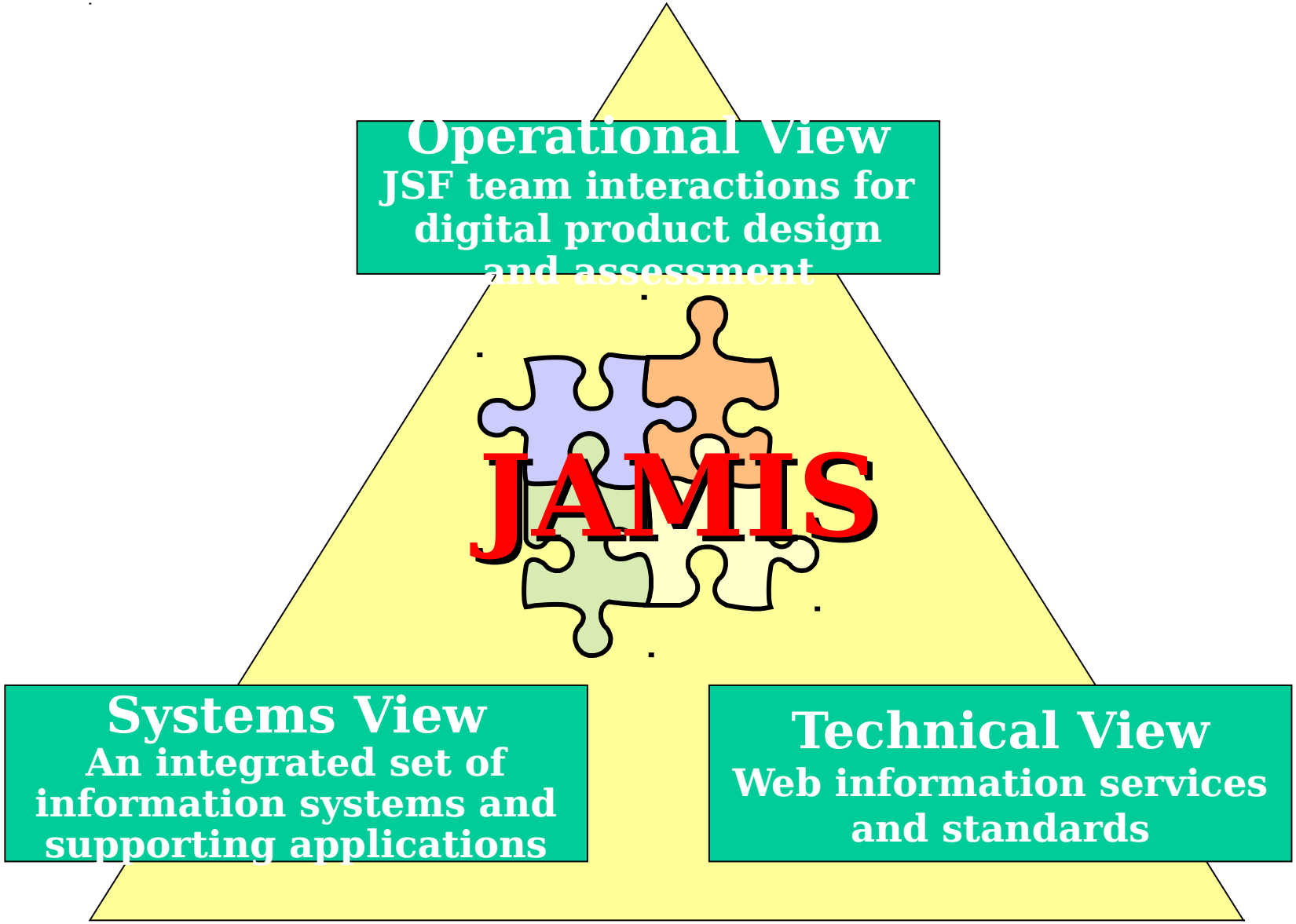
Three JAMIS Architectural Views


Operational View
JSF team interactions for digital product design and assessment
JAMIS
Systems View
An integrated set of information systems and supporting applications
Technical View
Web information services and standards

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Sources of this Requirement

- **JSF Modeling and Simulation Support Plan (MSSP)**
  - a government-produced contract reference document
- **JSF Acquisition Strategy**
- **LM Aero proposal**
- **SDD contract**
- **Integrated Master Plan events**
  - e.g., JSF Distributed Product Description (DPD) is a DAE IPR & DAB review exit criterion

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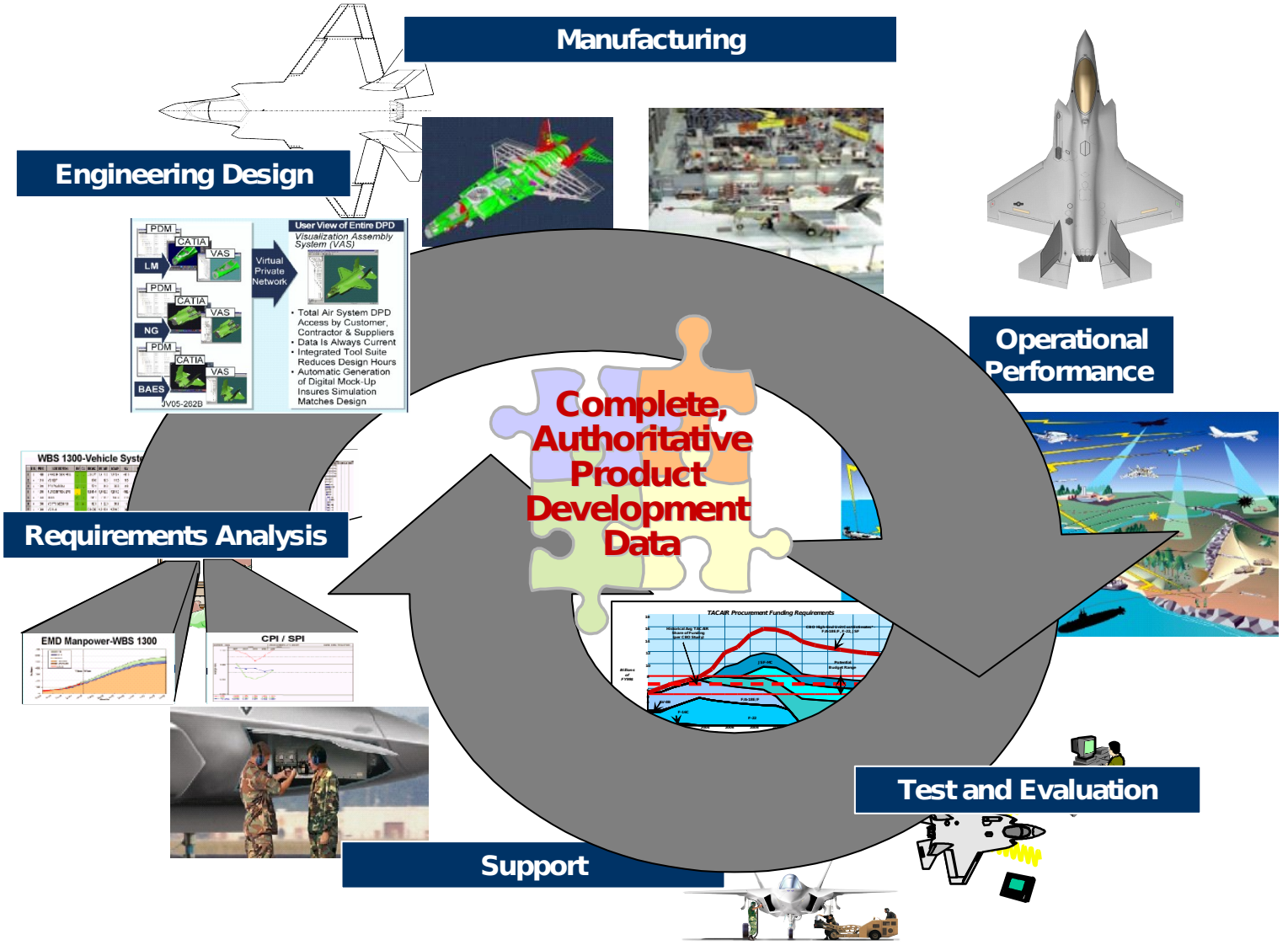
Simulation Based Acquisition (SBA): Shared Information is the Hub of IPPD



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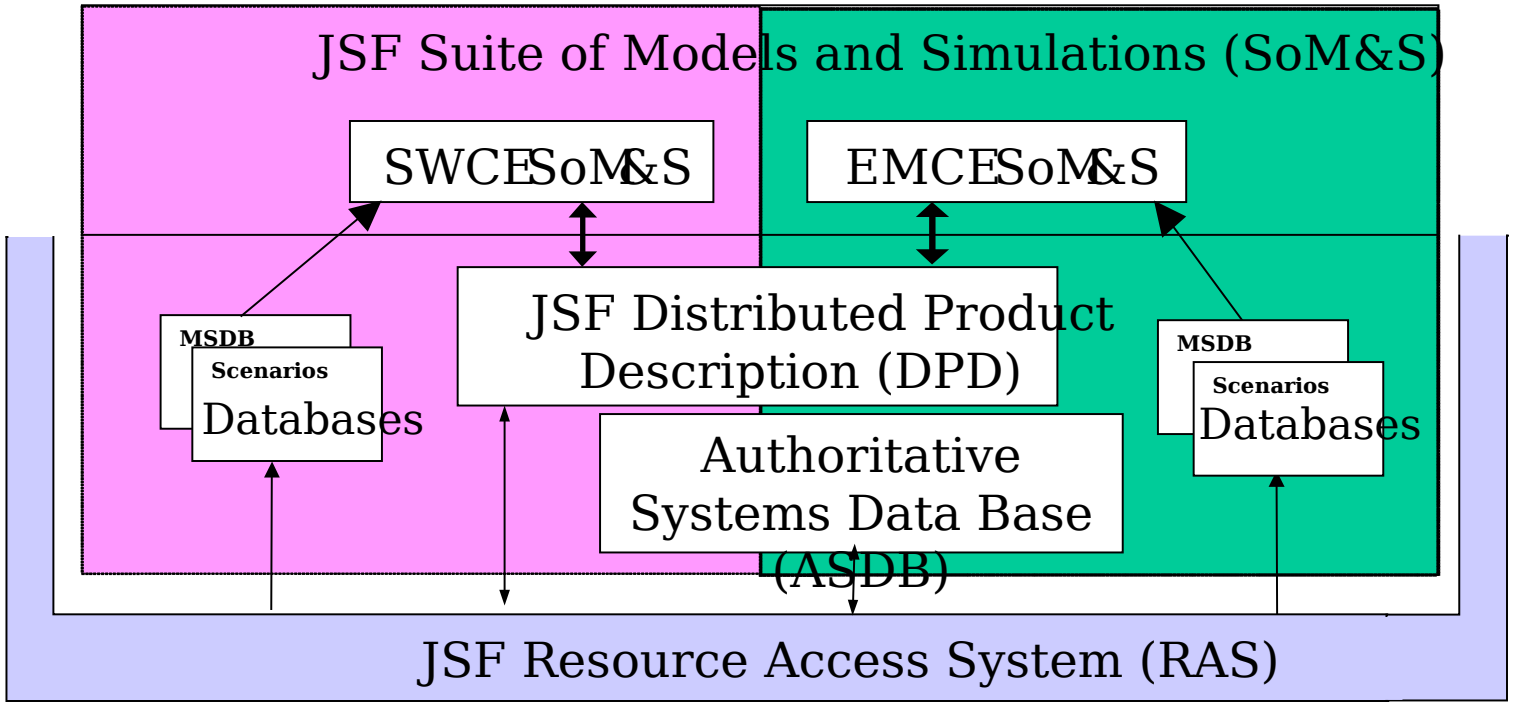
Components of the JSF Modeling & Simulation Toolset

JSF Strike Warfare Collaborative Environment (SWCE) Toolset (28 models & sims)

JSF Engineering and Manufacturing Collaborative Environment (EMCE) Toolset (100+ models & sims)



(JSF M&S Support Plan Fig. 5-1, annotated)

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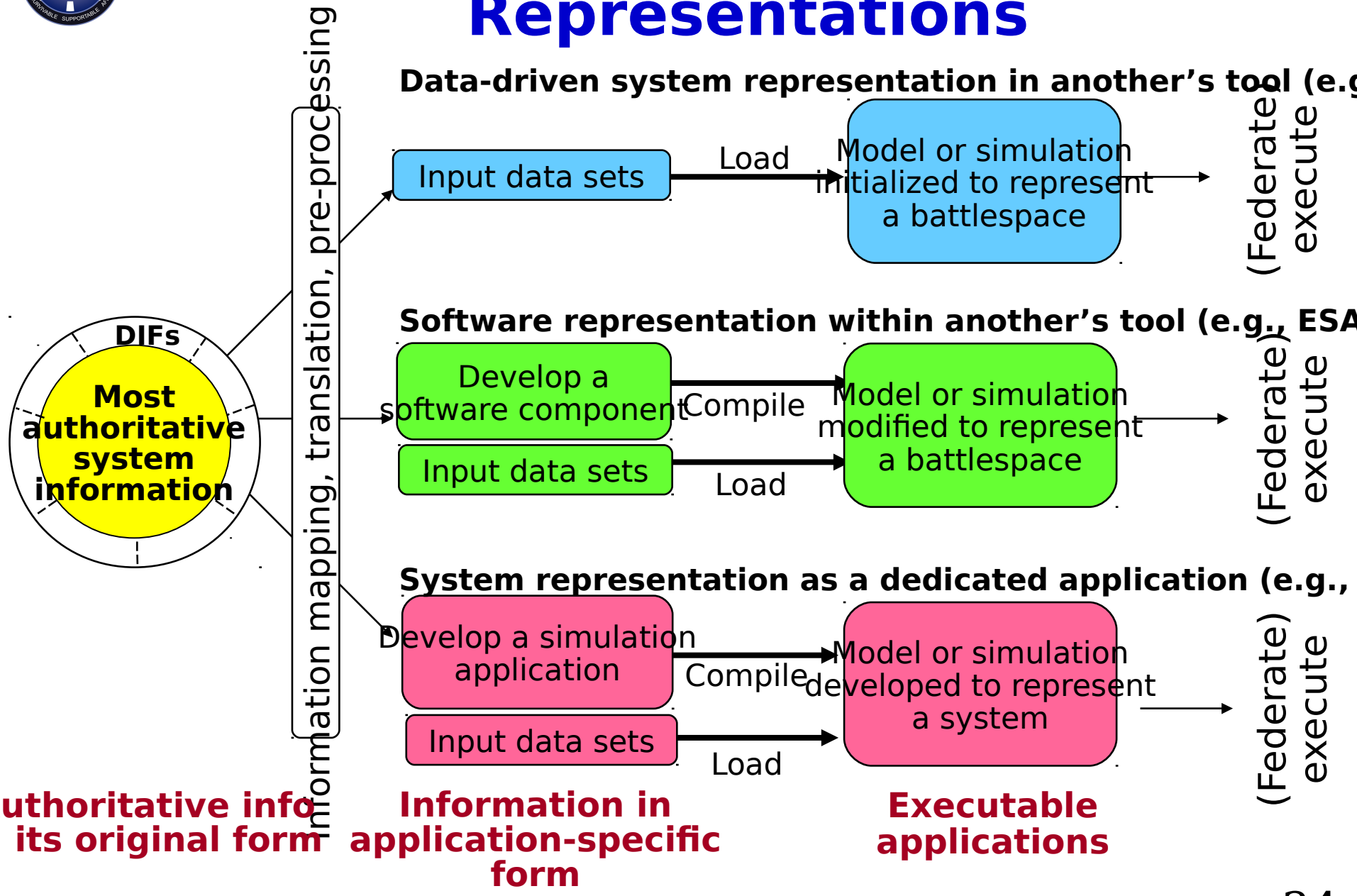
3 Paths to System Representations



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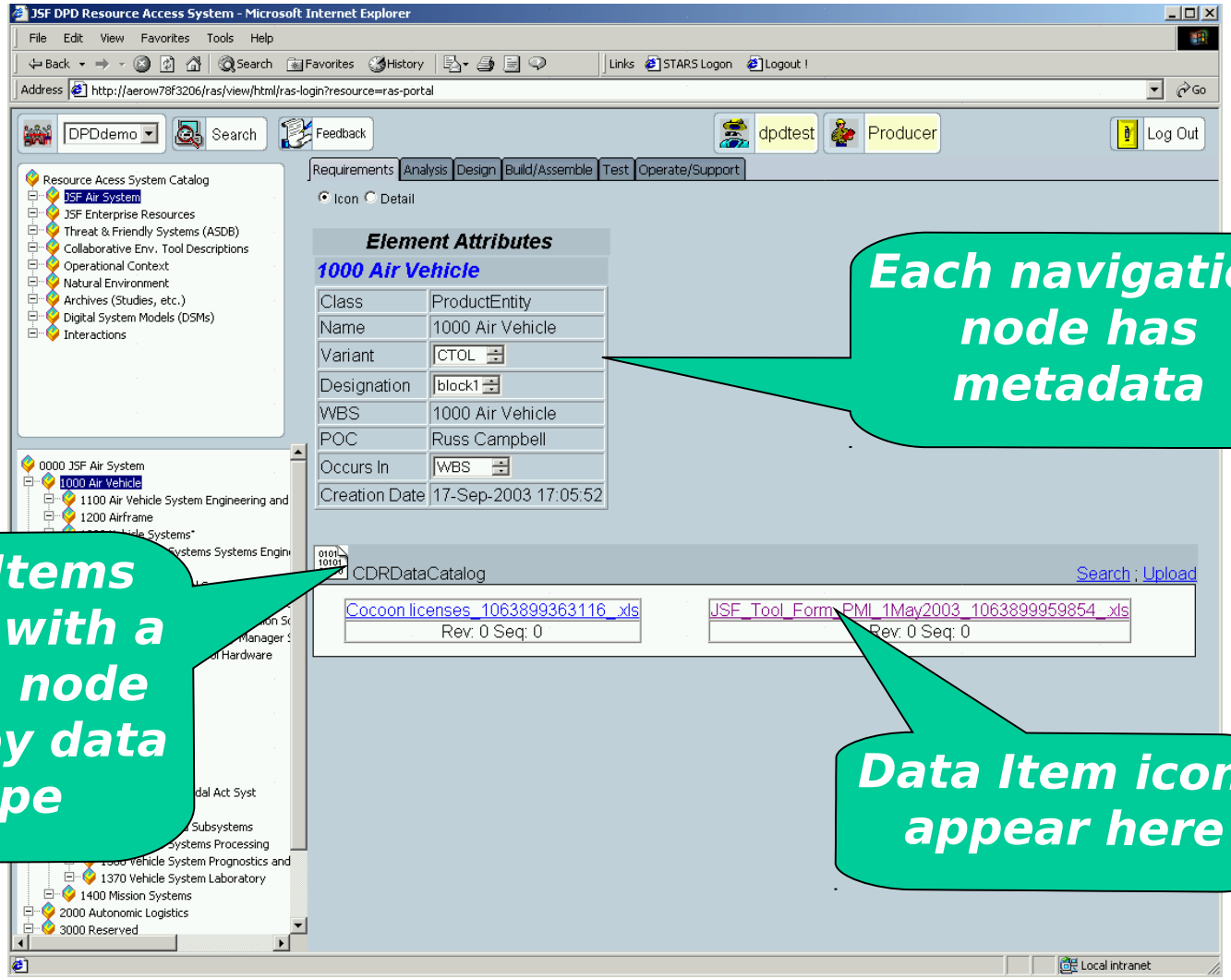
RAS User Interface Example



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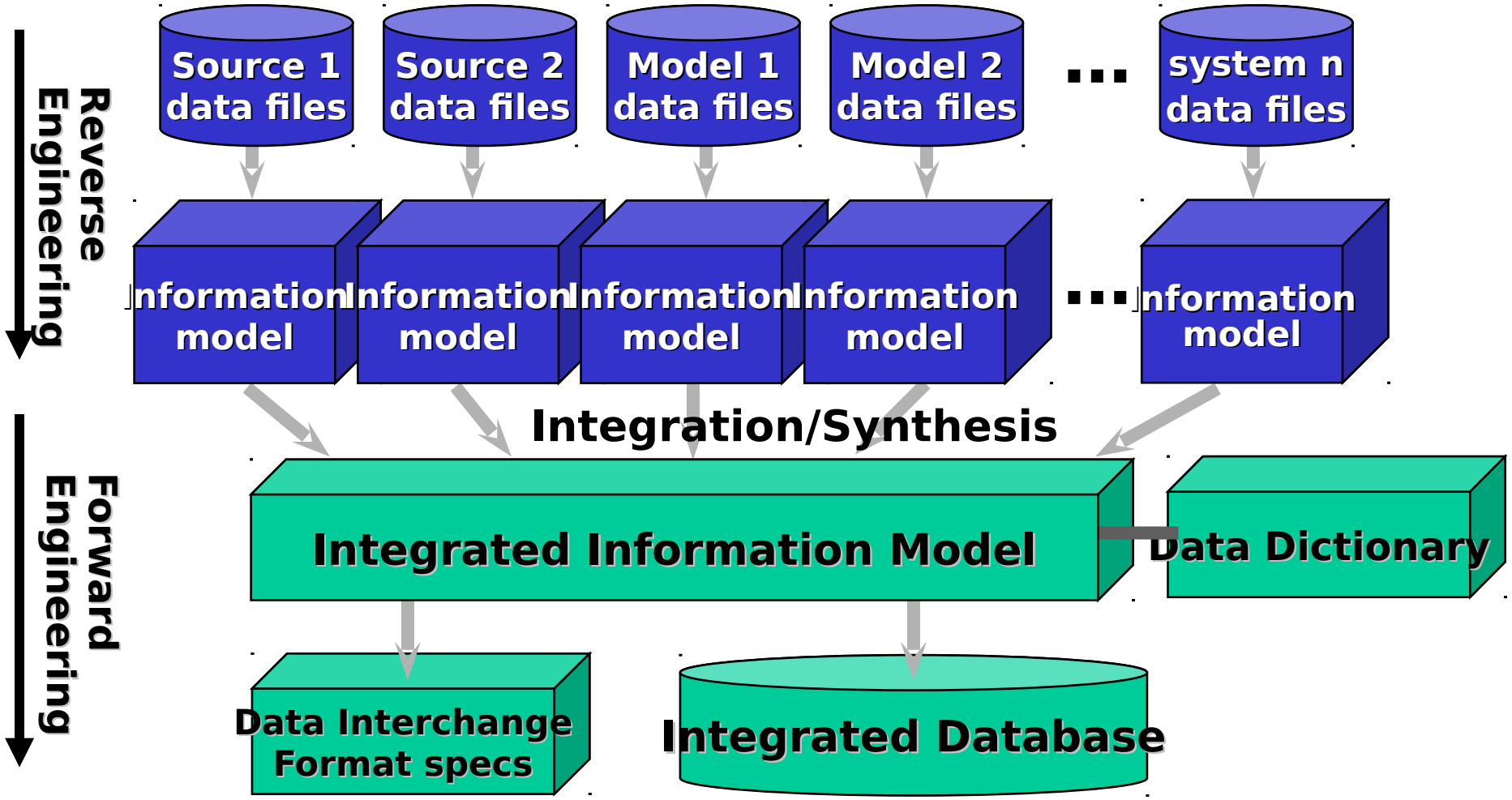
Data Engineering Process

Reverse Engineering for Data Integration and Sharing (REDIS) - simplified



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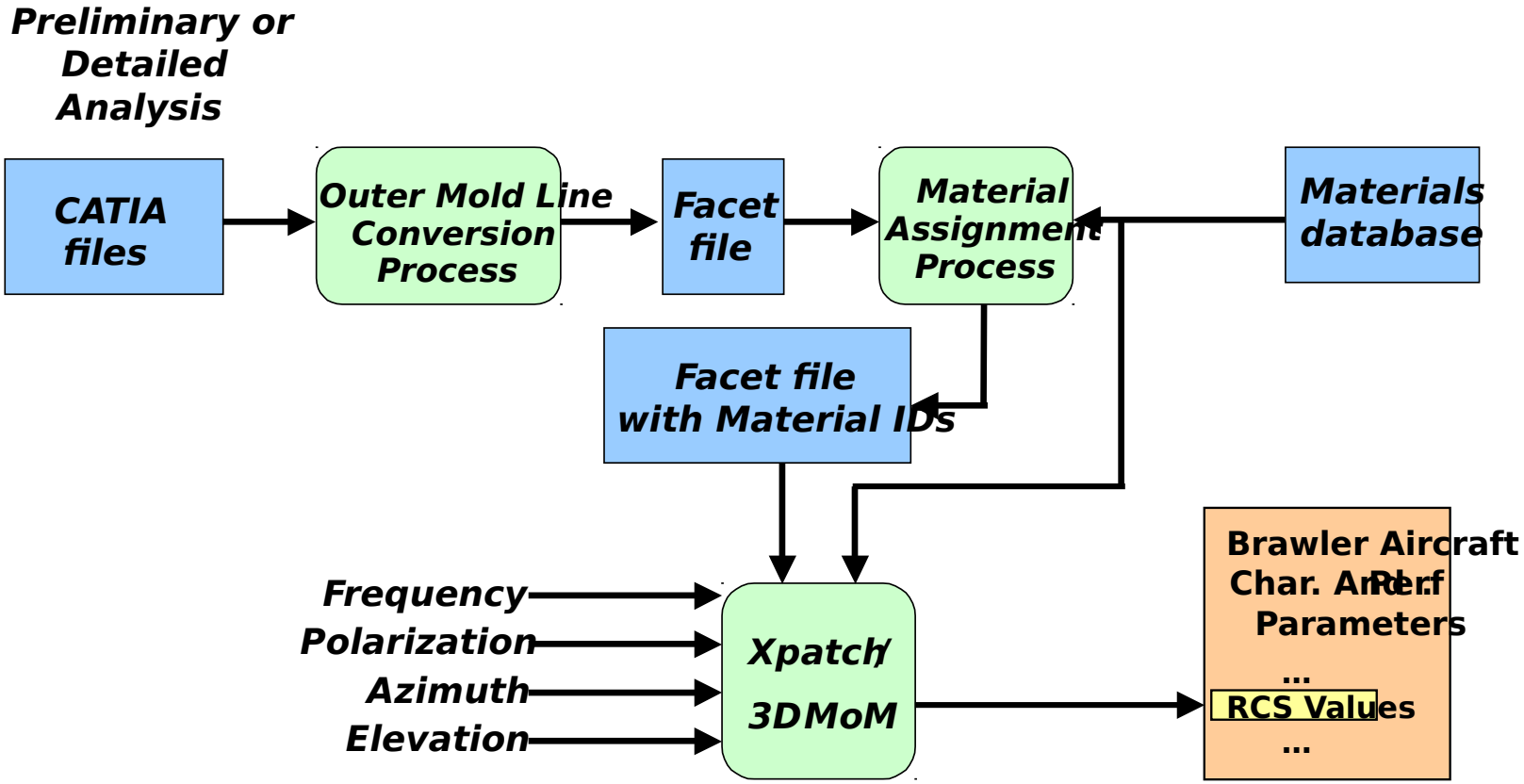
A Derivation Trace



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Sample Aircraft Performance Attributes

- Lift coefficient vs. angle-of-attack
- Temperature vs. mach, altitude, throttle
- Post-stall maneuver capability
- Min and Max g capacity
- Max mach number and calibrated airspeed
- Afterburner delay time
- Turbine spin-up and spin-down times
- Correlation factor for turbine to afterburner thrust
- Max mach number with a drag device
- Constraints on thrust reversal employment
- Time to max thrust reversal
- Thrust reversal efficiency
- Damping ratio for angle-of-attack response
- Roll acceleration factor due to angle-of-attack
- Stability axis roll rate limits by AOA and dynamic pressure
- Roll acceleration increment for positive AOA acceleration. limit
- Radar cross section by azimuth, elevation and wavelength
- Infrared signature characteristics
- Physical attributes
- Weapons quantities, operating modes and locations

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Shared Responsibilities During SDD

The Government will:	The SDD contractor shall:
Establish and maintain a Strike Warfare Collaborative Environment in which the DPD-based JSF representations will operate, that spans the collaboration focus areas of mission effectiveness analysis, autonomic logistics analysis, engineering and manufacturing analysis and cost analysis	Establish and manage an Engineering and Manufacturing Collaborative Environment
Provide configuration-managed versions of a JSF SWCE Suite of Models and Simulations	Develop, populate, and manage the JSF DPD, which, as a minimum, shall provide, via a DIF, all the JSF information needed to represent the JSF in the SWCE and the EMCE SoM&S.
Develop, maintain, and manage the configuration of a library of SWCE boxed sets. Develop translations and Digital System Models (DSMs) not provided by the WSC.	Develop the software that may be necessary to convert DPD information into the form needed to initialize or configure an individual model or simulation for that portion of the SWCE SoM&S that the WSC uses. This shall include translations and JSF Digital System Models.
Provide an Authoritative Systems Database (ASDB) which is accessible through the JSF Resource Access System	Develop and maintain a web-based JSF Resource Access System

JSF M&S Support Plan Table 1-1

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